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SHADE AVOIDANCE AND WHEAT (TRITICUM AESTIVUM L.) PRODUCTIVITY

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ABSTRACT

Two filed experiments were conducted at the experimental farm; faculty of Agriculture Benha University during 2012 and 2013 seasons to study the effect of shading through controlling plant density with using varied seed rates i.e., 40 kg./fed. as recommended for control, 10 kg/ fed. (as 1/4 of recommended; 20 kg/fed. (as 1/2 of recommended) and 30 kg /fed. (as 3/4 of recommended on wheat (*Triticum aestivum* L.) growth and productivity. The obtained results showed that, different applied treatments significantly increased all of the studied growth characteristics i.e. plant height, leaves number, tillers number, total leaf area, dry weight / plant and total chlorophyll SPDS at 70 and 110 days after sowing in both seasons. The highest values of these traits - except that of plant height, were existed with 10 kg/ fed. i.e. the quarter of the recommended amount of seeds. But in case of plant height, the highest value was existed with 40 kg/ fed. (i.e. control recommended amount in the two seasons. Also, the growth correlation: crop growth Rate (CGR), Net assimilation Rate (NAR) and photosynthetic efficiency (PE) significantly increased with all applications at 110 days after sowing in both seasons. As for yield and yield components, i.e., Number of spike/ plant, spike length, main spike weight (g), number of grains/spike, number of spikelets/spike and grain yield g / plant; significantly were increased with different applied treatments in the two seasons. The highest values were existed with the rate of seeds at 10 kg/ fed. (i.e, the quarter of recommended amount). In addition, the same rate of seeds gave the highest values of each of N, P, K, Mg, Ca, Fe, Zn, Cu, Total carbohydrates and crude protein content in Flag leaf at 110 days and in grains, as well, at harvest time during 2012 and 2013 seasons.

KEYWORDS: Wheat, Shade Avoidance, Seed Rates, Growth, Light Density, Yield, Mineral Contents

INTRODUCTION

Wheat plant (*Triticum aestivum*. L) is the most important and popular cereal crop in family poaceae, because it is the main international nutritional for human feeding. It is considered the main cereal crop not only in Egypt but also in many other nations, especially in developing countries. Also, it provided about 20 percent of food resources in the world (Farziet al, 2010).

It is well known that light plays a key role in plant integrity, determining their photo-morphogenesis and photosynthesis efficiency **(Avercheva*et al.*, 2009).** Also, the sun emits most of its radiation in the visible range; it covers the range of wavelengths from400-700nm **(Kolawole*et al.*, 2010).** In addition, light have a profound influence on plants by triggering physiological reactions to control their growth and development **(Briggs*et al.*, 2001; Clouse, 2001, Briggs and Olney, 2001; Stutte, 2009and Li *et al.*, *2010*),**

Plant density is one of the major factors that determining the ability of any plant to capture light energy; it is of interest that it is being under controlling by the farmers in most wheat-producing systems. It is of interest to define the relationships between density and crop yield quantitatively. Thereby, it could be establish the optimum populations to

reach the maximum attainable yields under various situations. In this respect, the effect of density on wheat plant size and crop productivity has received attention since, **Harper, (1977).** There is no stable recommendation by agronomists regarding the seed rates for unit area. For example, **Ciha (1993)** reported that the highest yield can be obtained by sowing 31.5 kg seed /ha. **While, Singh and Singh (1984), Khan (1993) and Shah (1994)** recommended that 42 kg seeds/ha gave the highest wheat grain yield.

In this respect, a number of factors could influence the rate of photosynthesis and respiration in plants; here the term net assimilation rate (NAR) that commonly is used as a measure of the rate of photosynthesis and reducing respiration losses. Since, factors that influence net assimilation rate are temperature, carbon dioxide, water, leaf age, minerals supply, nutrients, chlorophyll content and genotype beside light density, **Stoskopf, (1981).** The importance of the duration of photosynthesis to grain yield was reported by **Daynard*et al.* (1971)** supporting the role of **shade avoidance.** In wheat cultivation**, Spiertz*et al.* (1971)** found that from 61 to 83% variation in grain yield could be predicted from the duration of photosynthesis of the flag leaf and **sheath**. In this respect, the flag leaf is the final uppermost leaf (that completely is being lighted) to develop on cereal canopy and is formed just prior to fertilization. Beside, photosynthetic activity of a leaf canopy was found to reach a maximum after anthesis and declined rapidly there after.

Moreover, growth, yield and yield components could be increased most effectively if reasons for each input or crop production practices are considered in terms of how they will affect photosynthesis. The producers are growing wheat varieties under the ecological conditions of Egypt by using the same seed rates. That, could be exhibit great variability in the obtained yield. Therefore, the present study aimed to investigate the effect of shade minimizing through the seed rates, as related to wheat growth and productivity. Also, optimizing incident light on the plant canopy to determine the role of the physiological traits of wheat Misr 1 Varity under the Egyptian ecological conditions.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental farm of the Faculty of Agriculture at Moshtohor, Benha University during two successive growing seasons (2011/2012 and 2012/2013) to investigate the effects of different seed rates as 25, 50 and 75 % of the recommended and control as 100 % of the recommended seed rates in wheat (*Traticum aestivum L.)* Cv. Misr 1 on light density and shade avoidance and prolonged effects on yield and yield components.

The experiment included four treatments first, 10 kg/fed as 1/4 of the recommended second, 20 kg/fed. as 1/2 of the recommended third, 30 kg/fed as 3/4 of the recommended and fourth 40 kg/fed. (control) as recommended seed rates for wheat plants (*Triticum aestivum*) Cv. Misr 1. The experiments were arranged in randomized complete block design with three replicates. The plot area was 10.5 m2 (3x 3.5m). Wheat seeds were sown at the 25th of November in the two seasons. Calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48%K2O) were added to soil before the sowing in both seasons at the recommended rates of 100 and 50 kg/fed., respectively. Also, nitrogen fertilizer at rate of 90 kg/fed. Was applied through growth stage in forms of urea (46% N). The other required culture practices for growing Wheat plants were followed as recommended.

Sampling and Collecting Data

During the Vegetative and milking growth stages, ten plants were randomly chosen from each plot at 70 and 110 days after sowing in both seasons to estimate plant height (cm), number of leaves /plant, shoots dry weight (g) and

total leaf area (cm^2) using the disc method as described by **Derieux*et al.*, (1973)**, tillers number/ plant and Total chlorophyll content measured by chlorophyll meter (SPDS) Model SPAD 402.

Growth Correlation Data

- The crop growth rate (CGR) was estimated according to the equation of **Yaduraju and Ahuja (1996).**

  CGR (g/cm²/day) = W2 – W1/ T2 – T1

  W2 is the dry weight of plants at grain development stage at 110 days after sowing during the two seasons.

  W1 is the previous dry weight of plants at 70 days of plant age during the two seasons.

  T2 is the number of days at W2.

  T1 is the number of days at W1.

- Net assimilation rate (NAR): was estimated according to the formula of **Yaduraju and Ahuja (1996).**

  NAR (g/cm²/day) =log L2 - log L1/T2 – T1XW2 – W1/L2 – L1

  Log- is logarithm at base 10

  T2 is the number of days at W2.

  T1 is the number of days at W1.

  W2 is the dry weight of plants at grain development stage at 110 days after sowing during the two seasons.

  W2 is the dry weight of plants at grain development stage at 110 days after sowing during both seasons.

  W1 is the previous dry weight of plants at 70 days of plant age during both seasons.

  LA1 is the total leaf area at the days of W1. LA2 is the total leaf area cm^2 at days of W1.

- The, photosynthetic efficiency: was calculated by the following formula based on sunlight energy that received for ageo graphic site (Qalubia-Egypt) and on dry matter produced **Stoskopf (1981).**

  Photosynthetic efficiency (P.E) % = Energy output/ Energy in put x100

  Where:

  Energy output= dry weight (Excluding 25% respiration loss) x

Energy (energy required for synthesis of one kilogram of glucose) Energy input = estimated solar energy striking a land area (1 m2) during 170 days of the growing season of wheat (at Qalubia Gavernorate, Egypt).

Energy required for the synthesis of one kilogram of glucose = 1579.2 J m-2

Estimated solar energy at Qalubia Egypt = 1325.56 mega J /m^2.

Meteorological Weather Station, The Agricultural Research Center, Faculty of Agriculture, Moshtohor, Benha University, Qalubia Gavernorate, Egypt (2013).

Data of Yield and Yield Characteristics

At the end of plant age Ten plants were randomly chosen from each plot to measured plant height, Number of spike / plant, spike length cm, main spike weight, number of grains/spike, number of spikelets / spike and grain yield per plant.

Chemical Composition

Samples of Flag leaves at 110 days after sowing and grains at harvest time were taken to determine total nitrogen as described by **Horneck and Miller (1998),** phosphorus by**Sandell (1950),** potassium **by Horneck and Hanson (1998).**

While Ca, Mg) Fe, Zn and Cu as described by **A.O.A.C. (1990)**. Yet, the Crude protein was calculated according to the followings equation: Crude protein= total nitrogen x 5.75**(A.O.A.C., 1990).** Total carbohydrates, were determined according to **Dubois *et al.*(1956**).

Statistical Analysis

All data were statistically analyzed and the means were compared using the least significant difference Test (LSD) at 5% level according to **Snedecor and Corchran (1980).**

RESULTS AND DISCUSSIONS

Growth Characteristics

Data in Tables 1 and 2 illustrate the effect of different seed rates i.e. 40 kg/ fed. that recommended as control; 10 kg/fed. as quarters of the recommended; 20 kg/fed. as half of the recommended and 30 kg /fed as three quarters of the recommended on growth characteristics i.e. plant height, leaves number, tillers number, total leaf area, shoots dry weight / plant and total chlorophyll SPDS of wheat plants (*Triticum aestivum* Cv. Misr1) at 70 and 110 days of plant age during 2012 and 2013 seasons. The results obtained show that plant height significantly was increased at 70 days of plant age and gave the highest value at 30 kg /fed (3/4 as recommended). In contrast, at 110 days of plant age 40 kg/fed. (recommended as control) gave the highest value of this trait during 2012 and 2013 seasons. As for the leaves num., tillers number, total leaf area, dry weight and Total SPDs / plant were significantly increased and gave the highest value of these traits at 10 kg/fed. followed by 20 kg/fed.

Table 1: Effect of Different Seed Rates of Wheat Cv. Misr 1 on Growth Characteristics at 70 Days of Plant Age During 2012 and 2013 Seasons

Characteristics / Seed Rates		Plant Height cm		Leaves Number/Plant		Tillers Num. /Plant		Total Leaf Area cm2/Plant		Dry Weight (g)/Plant		Total Chlorophyll SPDS	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control as the recommended	40 kg/fed	75.02	87.25	33.22	33.80	5.33	5.66	740.25	755.85	15.20	22.15	90.25	95.17
Quarter of recommended	10 kg/fed	78.01	82..23	60.66	68.66	18.66	19.33	936.45	940.82	21.15	55.33	150.15	165.17
Half of recommended	20 kg/fed	89.20	91.24	55.33	60.40	13.00	14.00	830.23	855.36	19.18	44.89	120.14	133.14
Three quarter of recommended	30 kg/fed	90.03	92.40	48.00	50.33	10.33	11.66	910.15	929.78	20.49	49.65	112.13	120.35
L.S.D. at 5 %		1.56	1.87	3.58	4.02	3.21	3.55	90.98	92.24	2.73	4.82	5.62	7.23

Table 2: Effect of Different Seed Rates of Wheat Cv. Misr 1 on Growth Characteristics at 110 Days of Plant Age During 2012 and 2013 Seasons

Characteristics / Seed Rates		Plant Height cm		Leaves Number/Plant		Tillers Num. /Plant		Total Leaf Area cm2/Plant		Dry Weight (g)/Plant		Total Chlorophyll SPDS	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control as the recommended	40 kg/fed	95.02	97.25	38.22	40.80	8.33	10.66	1040.22	1142.15	24.20	60.25	110.25	115.37
Quarter of recommended	10 kg/fed	92.01	93.23	68.66	72.66	20.66	22.33	1620.14	1714.32	45.51	110.35	183.34	195.12
Half of recommended	20 kg/fed	91.20	94.24	62.33	65.40	14.00	15.33	1420.33	1530.75	30.33	100.19	140.44	153.18
Three quarter of recommended	30 kg/fed	92.03	93.40	55.00	60.33	13.33	14.66	1230.14	1319.23	32.14	101.13	132.13	140.35
L.S.D. at 0.05 %		1.02	1.23	2.23	3.55	2.15	2.62	102.22	110.52	3.45	9.25	7.12	8.32

On the other hand, the lowest values in these traits were gained with 40 kg/ fed., i.e. the control at 70 and 110 days during 2012 and 2013 seasons.

In this respect, it is of interest to note that; the only plant height was significantly decreased with the lowest seeds rate i.e. 10 kg/ fed. at 70 days of plant age at 2013 seasons as well as with different applied seed rates at 110 days of plant age during 2012 and 2013 seasons. This reduction of plant height was accompanied with significant increase of all other studied growth traits.

Here, data in Tables (1 and 2) clearly indicate that obvious increase in dry matter accumulation was existed at the two ages (i.e. 70 and 110 days) during the two seasons of the present study (i.e. 2012 and 2013 seasons). This evident increase of dry weight per plant of this wheat cultivar was preceded and /or accompanied with great abundance in photosynthesis pigments formation. Also, the highest total area of leaves that reached in the two seasons with the lowest seed rate (10 kg) was the direct positive effects of this seed rate upon each of tillers and leaves number. Thereby, to avoid shedding and to achieve high lighting through lowering the number of plants per soil unit area; is being of great interest. So, under these circumstances of shade avoidance, vigorous growth with its best characteristics is being obtained.

Growth Correlation

Data in Table 3 clearly indicate that different applied seed rates (i.e. 40 kg/ fed. recommended as controls; 10; 20 and 30 kg /fed as 1/4, 1/2 and 3/4 of the recommended, respectively increased crop growth rate (CGR), net assimilation rate (NAR) and photosynthetic efficiency (PE) as growth correlation at 110 days of plant age during 2012 and 2013 seasons. The highest significant value was existed with 10 kg/fed. as 1/4 of the recommended seeds rate.

In this respect, the obtained increase of these traits could be attributed to increase of all growth characteristics (Tables 1 and 2) and that is a direct and positive effects of light upon activating and maximizing of different physiological processes estimated in this study. The great variation of CGR between low and high plant populations indicate the problems of less efficient photosynthetic activity due to their source to sink relation and managing of leaf area through plant population. Our results support the results reported by **shuyuan *et al.* (1995).** Also, **Afzaal *et al.* (2006)**, **Iqtidar *et al.*, (2010) and Elena and Jafou (2012).** Found non-significant correlation of grain yield with net photosynthesis among different genotypes of wheat. But, they found significant and positive correlation with fresh green biomass and Co2 with photosynthesis fixation. They further argued that net photosynthesis and transpiration are directly and indirectly is determined with the prevalent growth conditions and that is reversing and correlated with fresh biomass and grain yield.

Table 3: Effect of Different Seed Rates of Wheat Cv. Misr 1 on Growth Correlation during 2012 and 2013 Seasons

Characteristics / Seed Rates		Crop Growth Rate (CGR)) g/cm2/ Day		Net Assimilation Rate (NAR) g/cm2/ Day		Photosynthetic Efficiency (P.E) %	
		2012	2013	2012	2013	2012	2013
Control as the recommended	40 kg/fed	0.374	0.953	0.518	2.194	1.636	4.078
Quarter of recommended	10 kg/fed	0.600	1.376	1.403	3.168	3.076	7.468
Half of recommended	20 kg/fed	0.274	1.383	0.642	3.184	2.050	6.781
Three quarter of recommended	30 kg/fed	0.191	1.287	0.671	2.964	2.172	6.844
L.S.D. at 5 %		0.125	0.268	0.325	0.586	0.754	1.125

Yield and Yield Components

As shown in Table 4 different applied seed rates significantly increased plant height at harvest time during 2012 and 2013 seasons. The highest value of this trait was existed with 40 kg/fed. Recommended (i. e. Control). But the lowest increase of this trait was existed with 10 kg/fed. (quarter of the recommended in both seasons). This result is being of great interest, since it was accompanied and followed with significant increase of different yield parameters.

In this respect, data in Table 4 indicate that number of spike/plant, spike length, main spike weight (g), number of grains/spike, number of spikelets/spike and grain yield g / plant significantly were increased at harvest time during 2012 and 2013 seasons. In the same context, the highest values of these traits were existed with 10 kg/fed. i.e. the quarter of the recommended rate in the two seasons. These results are in agreement with **Iqtidar *et al.*, (2010) and Elena and Jafou (2012).**

In this respect the obtained increase in yield and yield components is mainly could be attributed to the vigorous growth characteristics Tables 1 and 2 and growth correlation Table 3 and followed by improving different yield characteristics Tables 4, 5, 6, 7 and 8 as well mentioned after words).

Table 4: Effect of Different Seed Rates of Wheat Cv. Misr 1 on Yield Characteristics during 2012 and 2013 Seasons

Characteristics / Seed Rates		Plant Height		Num. of Spike/ Plant		Spike Length cm		Main Spike Weight (g)		Num. of Grains/ Spike		Num. Spikelet/Spike			Grain Yield g/Plant
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control as the recommended	40 kg/fed	110.2	115.4	9.66	10.00	14.25	15.55	15.25	18.13	55.00	58.00	21.33	18.00	120.1	123.5
Quarter of recommended	10 kg/fed	105.1	106.2	21.00	23.33	22.13	23.14	35.22	38.25	82.33	90.45	28.33	25.33	140.2	185.6
Half of recommended	20 kg/fed	107.3	108.8	15.33	16.25	18.42	19.25	30.12	32.14	75.15	80.15	25.66	22.66	135.3	138.8
Three quarter of recommended	30 kg/fed	108.2	111.6	14.66	14.14	17.33	18.19	25.95	35.22	72.14	75.30	24.00	23.33	130.4	133.7
LSD at 5 %		1.01	0.95	2.32	3.14	3.25	3.56	3.15	4.25	8.15	9.25	3.15	2.58	5.15	7.87

Mineral Concentrations and Some Bioconstituents

Data in Tables 5, 6, 7 and 8 indicated that different applied seed rates i.e. (40 kg. fed. as recommended for the control; 10 kg/ fed. the three quarter of recommended; 20 kg/fed. half of recommended and 30 kg /fed. Three quarter of

recommended; significantly increased N, P, K, Mg, Ca, Fe, Zn, Cu, Total carbohydrates and Crude protein in Flag leaf at 110 days and in grains at harvest time during 2012 and 2013 seasons respectively. It is more evident that the highest value of these traits were existed with 10 kg/ fed. the quarter of recommended in both seasons.

In this respect, the obtained increase of these traits could be mainly attributed to that increase of minerals absorption and followed by accumulation in different plant parts leading to stimulation of plant growth and photosynthesis (higher biomass production) and assimilates transport action to sink and finally increased grain yield/plant. Similar results were obtained by **Iqtidar*et al.*, (2010) and Elena and Jafou(2012).**

Table 5: Effect of Different Seed Rates of Wheat Cv. Misr 1 on Some Minerals Content in Flag Leaf at 110 after Sowing During 2012 and 2013 Seasons

Characteristics / Seed Rates		N %		P %		K %		Mg %		Ca %		Fe PPM	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control as the recommended	40 kg/fed	2.68	2.70	0.85	0.95	1.85	2.00	0.234	0.242	0.215	0.220	80.15	81.29
Quarter of recommended	10 kg/fed	4.89	4.90	0.93	1.10	1.93	2.33	0.284	0.275	0.250	0.265	92.18	95.15
Half of recommended	20 kg/fed	3.24	3.40	1.02	1.15	2.16	2.60	0.274	0.264	0.245	0.248	85.25	89.54
Three quarter of recommended	30 kg/fed	3.96	3.15	1.22	1.25	2.03	3.25	0.264	0.256	0.225	0.230	89.14	90.23
L.S.D. at 5 %		1.15	1.26	0.12	0.12	0.12	0.28	0.12	0.13	0.10	0.12	6.56	7.55

Table 6: Effect of Different Seed Rates of Wheat Cv. Misr 1 on Some Minerals and Bioconstituents Content in Flag Leaf at 110 after Sowing During 2012 and 2013 Seasons

Characteristics / Seed Rates		Zn PPM		Cu PPM		Total Carbohydrates %		Crude Protein %	
		2012	2013	2012	2013	2012	2013	2012	2013
Control as the recommended	40 kg/fed	25.14	20.14	9.15	9.29	26.75	30.15	15.41	15.53
Quarter of recommended	10 kg/fed	30.35	31.15	12.12	12.56	34.94	40.25	28.12	28.18
Half of recommended	20 kg/fed	29.25	28.36	10.13	11.20	35.71	38.39	18.63	19.55
Three quarter of recommended	30 kg/fed	26.24	30.25	11.89	12.20	41.62	42.15	22.77	18.11
L.S.D. at 05 %		2.32	2.59	1.97	2.16	3.75	3.89	2.17	2.36

Finally, this study clearly confirmed the importance of avoidance intensive shedding of growing wheat plants through minimizing the amount of sown seeds to that limit is being suite passage enough incident light through the canopy.

This critical light level would be reversed upon vigorous growth characteristics Tables 1 and 2, improving their growth correlations Table 3, maximizing the final grain yield preceded with different its characteristics Tables 4, 5 and 6. Therefore, the present study strongly admit and recommend the use of either10 are 20 kg/fed. Seeds of wheat Cv. Misr 1

Furthermore, in Egypt the enlargement of sowing this great success of wheat cultivar, i.e. Misr 1 is being of interest to some extent on the right way to minimize that gap between the consumption, requirements and the production of wheat grains.

CONCLUSION

The present study strongly admit and recommend the use of 10 kg/fed. seeds of wheat Cv. Misr 1. To avoidance intensive shedding of growing wheat plants and maximizing morphological, and physiological characteristics as well as yield and grain quality of wheat plants.

Furthermore, in Egypt the enlargement of sowing this great success of wheat cultivar, i.e. Misr 1 is being of interest to some extent on the right way to minimize that gap between the consumption, requirements and the production of wheat grains.

Table 7: Effect of Different Applied Seed Rates of Wheat Cv. Misr 1 on Some Minerals Content in Grains at Harvest Time (i. e., 177 Days) During 2012 and 2013 Seasons

Characteristics / Seed Rates		N %		P %		K %		Ca %		Mg %		Fe PPM	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control as the recommended	40 kg/fed.	1.96	2.00	1.10	1.15	1.32	2.15	0.100	0.112	0.100	0.115	50.40	53.15
Quarter of recommended	10 kg/fed.	2.42	2.51	1.25	1.30	1.95	2.12	0.194	0.192	0.150	0.160	75.14	78.25
Half of recommended	20 kg/fed.	2.11	2.23	1.30	1.43	2.02	2.50	0.161	0.162	0.124	0.130	62.13	65.35
Three quarter of recommended	30 kg/fed.	1.99	2.35	1.35	1.50	1.73	1.85	0.151	0.153	0.138	0.145	65.36	68.36
L.S.D. at 5 %		0.33	0.29	0.115	0.12	0.35	0.23	0.115	0.`18	0.42	0.52	6.25	7.28

Table 8: Effect of Different Applied Seed Rates of Wheat Cv. Misr 1 on Some Minerals and Bioconstituents Content in Grains at Harvest Time (i.e., 177 Days) during 2012 and 2013 Seasons

Characteristics Seed Rates		Zn PPM		Cu PPM		Total Carbohydrates %		Crude Protein %	
		2012	2013	2012	2013	2012	2013	2012	2013
Control as the recommended	40 kg/fed.	19.15	20.15	5.12	6.12	65.30	66.15	11.27	11.50
Quarter of recommended	10 kg/fed.	26.14	28.26	6.18	7.25	75.56	78.19	13.92	14.43
Half of recommended	20 kg/fed.	20.38	23.48	7.15	7.10	72.40	73.29	12.13	12.82
Three quarter of recommended	30 kg/fed.	23.15	26.39	6.16	6.30	73.25	75.43	11.44	13.51
L.S.D. at 5 %		1.26	1.75	0.65	0.55	1.73	1.45	0.73	0.65

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